David Knight. The Making of Modern Science: Science, Technology, Medicine, and Modernity, 1789—1914.
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Source: *Isis*, Vol. 102, No. 2 (June 2011), pp. 369-371

the deeper properties of the integers, how it appeared to contemporaries and successors, and why it provoked the interest that it did have until now been analyzed only in connection with a few isolated issues, and such studies have largely reflected a present-oriented view of what the important issues were for the actors.

The Shaping of Arithmetic after C. F. Gauss's Disquisitiones arithmeticae overcomes this problem, in no small measure thanks to what was obviously a very serious editorial effort to get all the authors on the same page and make sure that the findings of each writer were incorporated into the various essays. The result is a methodologically sophisticated and insightful volume that will be a major reference point for anyone working on related material for the indefinite future. It's a big book, with eighteen authors and almost six hundred pages, and it mixes the work of well-established scholars with that of recent Ph.D.'s. Given this size, a brief review can't really begin to discuss all the contributions. Broadly accessible to historians in some parts, highly technical in others, the book contributes to our understanding of the subject and the period with originality and authority.

The tone of the volume is set by two long essays at the beginning, coauthored by Catherine Goldstein and Norbert Schappacher, that do a great deal to situate number theory in the broader mathematical framework of the nineteenth century. This contextualization is achieved by a convincing argument for the practice of what the authors term "arithmetic algebraic analysis." The algebraic approach to analysis, dominant in the late eighteenth century, retained more power for much of the nineteenth century than conventional histories credit; and part of that persistence, as can be seen from these essays, is due to the continued relevance of the approach in the increasingly important theory of numbers. So important was this that it provided much of the immediate background for the refounding of analysis on the basis of arithmetic, cogently discussed here by José Ferreirós. Indeed, the reordering of the mathematical hierarchy, with leadership passing from geometry to arithmetic, was accompanied by a rethinking of the number concept, traced here in the essay by Jacqueline Boniface. Boniface argues that the extension of the domain of arithmetic was largely constitutive of the rethinking of mathematical foundations that took place in the late nineteenth and early twentieth centuries, and it is one of the virtues of the collection that the role of the heritage of Gauss in this fundamental transition is clearly illuminated and historicized.

Many of the essays comment on the reception of the *Disquisitiones* and the concomitant development of number theory in specific local contexts. The coverage here is broad, if not universal, with a discussion of aspects of the reception not only in the "big three" of Germany, France, and Italy but also in Russia and the United States. In the case of the French context, which I know best, Goldstein gives a close mathematical reading of Charles Hermite's work to approach deep questions about the resemblance between his work and that in Germany; one is struck by the interest of the questions she raises and by the way in which the answers are deeply grounded in the mathematical practice of Hermite, approached in their own context rather than anachronistically. By contrast, Anne-Marie Décaillot's essay on number theoretic work done by members of the Association Française pour l'Avancement des Sciences draws our attention to practices among a group that, for the most part outside the mathematical mainstream, sought to domesticate this new area of research in a specific context. The selection of such a population for investigation is typical of the originality of the volume, which repeatedly draws our attention to fresh or underanalyzed sources—for example, in the essay by Reinhard Bölling on a manuscript of E. E. Kummer. Only in one or two essays does an author fall into a kind of technical recitation, combining so-called natural developments with flashes of individual brilliance, in a narrative form that was characteristic of an earlier generation of work on the history of mathematics.

This volume deserves a wide audience, both among the mathematically able and among historians of nineteenth-century science. Mathematics was, for many of that time, at the pinnacle of the academic hierarchy, and many of the issues explored here revise our image of the field, and of number theory in particular, in important ways. The many exemplary essays in the volume also attain a fine level of exposition in English, something that does not go without saying in a multinational group of authors.

THOMAS ARCHIBALD

David Knight. *The Making of Modern Science: Science, Technology, Medicine, and Modernity, 1789–1914*. xiv + 370 pp., illus., index. Cambridge: Polity Press, 2009. $31.95 (paper).

With general readers as well as fellow historians of science obviously in mind, David Knight has

arranged a large amount of historical scholarship according to several themes. His twelve chapters take his story from the French-centered science of the late eighteenth century to a more international scene at the end of his long nineteenth century. Along the way, he considers numerous aspects of science: its links to technology and medicine, its geographical context, its degrees of professionalism, its place in society, its educational support, and—not least—its ideas. Historians should find *The Making of Modern Science* an interesting overview, and nonhistorians will find it an insightful though challenging introduction to the subject.

After Chapter 1, "Science in and after 1789," Knight turns to "Science and Its Languages," considering Lavoisier's chemical nomenclature, mathematics, models, paintings by John James Audubon and John Constable, and the language of design as in the Bridgewater Treatises. "Applied Science" explores the interplay between science and technology, discussing dyes, agriculture, railways, telegraphs, and so on. Knight notes the gradual development of engineering education and the growing influence of scientific theory on practical inventions. Thermodynamics and evolutionary theory caused "Intellectual Excitement" (the title of Ch. 4), each unifying several previously separate areas of science.

In Chapter 5, "Healthy Lives," Knight takes on medicine and discusses some of the century's leading physicians, members of the first scientific profession. He explains their increasing educational standards and how they coped with problems such as cholera, poisons, germs, and public health. "Laboratories" mainly concerns the growth of chemical laboratories but also ones in physics, most notably the Cavendish Laboratory at Cambridge University. "Bodies, Minds, and Spirits" addresses the science of humans, highlighting questions of racial distinctions, evolutionary origins, and spiritualism. "The Time of Triumph" continues themes from Chapter 3, investigating late-century science's greater impact on technology.

Chapter 9, "Science and National Identities," addresses national competitions similar to the modern Olympic Games but also considers different countries' strengths in different areas of science, as well as different national emphases, such as France's concern for theoretical achievements and Britain's for practical science. And there was warfare. "Method and Heresy" explores the century's search for science's proper method. Methodologies competed, of course: Auguste Comte's positivism, John Herschel's true causes, William Whewell's fundamental ideas, and then Ernst Mach's version of positivism are some examples. In this chapter, Knight also examines what he calls "bad science" (p. 226) and "failed sciences" (p. 229). "Cultural Leadership" records science's increasing importance within society—greater support for its research, greater professional importance in conflicts with clergymen, greater influence on (for example) art and literature—setting the stage for his final chapter, "Into the New Century."

The inclusion of Santa Claus and Knight's grandmother in the text indicates the author's interest in general readers. Santa Claus is an analogy for the relief—rather than sense of crisis—experienced by some at their loss of religious faith. That loss was "like abandoning belief in Santa Claus and no longer having to go uneasily through rituals that have become meaningless" (p. 183). Knight's American grandmother's memories provide evidence about the closing of the American frontier in 1890. Knight mentions the "growl" of his own physics teacher (p. 82) and a talk by Harold Macmillan that he heard at the Oxford Union. Such examples of his occasionally chatty style undoubtedly reflect Knight's interest in general readers, which is also evident in his very first sentence: "Of all the inventions of the nineteenth century, the label 'scientist' was one of the most striking" (p. viii). Historians of science already know about Whewell's invention of that word, but others (I find) usually have no idea—though they are fascinated by the story.

Despite Knight's genuine interest in them, however, these nonhistorians may well find his book hard going at times. Condensing a huge subject into a book of reasonable length leaves some topics insufficiently explained. Paracelsus, Pythagoras, G. G. Stokes, "the logic of Hume and Mill" (p. 273), and even phlogiston are a few of the people and topics too briefly mentioned to be generally understood.

As Knight acknowledges in disclosing that he has "used examples from Britain out of greater familiarity with that context" (p. xii), his book very much reflects his own research as well as that of others. He is best known for his work on nineteenth-century British chemistry. He here discusses science much more than either technology or medicine, and chemistry more than any other science. Humphry Davy, subject of a biography by Knight, receives more attention than any other "scientist." Davy's protégé, Michael Faraday, captures second place. This is not a criticism, but it does raise the question of what such a book would look like if written by, say, a specialist on nineteenth-century French biology or nineteenth-century German physics or nineteenth-century

American technology. Their books would surely be quite different from Knight's. As Knight himself says in concluding *The Making of Modern Science*: "It is a complex story, and different people will seek different threads to guide them through the labyrinth" (p. 282).

DAVID B. WILSON

Sally Gregory Kohlstedt. *Teaching Children Science: Hands-On Nature Study in North America, 1890–1930.* xv + 363 pp., illus., apps., bibl., index. Chicago/London: University of Chicago Press, 2010. $45; £29 (cloth).

In 1908, Columbia Teachers College in New York City maintained an extensive school garden and greenhouse where prospective teachers studied basic horticulture in preparation to teach "nature study." This garden, shown on page 149 of Sally Gregory Kohlstedt's well-researched book, extended for a full city block. Here, as at many normal schools across the country, student teachers spent time planting seeds, harvesting vegetables, and identifying insects. They learned to integrate literature and social studies lessons with scientific topics and to incorporate lessons on environmental conservation with elementary science fieldwork. As a result of this kind of preparation, increasing numbers of schoolchildren engaged in nature study from 1890 to 1930, examining plant and animal specimens, tramping through local fields to study geological features, and conducting experiments to eradicate mosquitoes, improve water retention in the soil, or increase crop production.

As Kohlstedt so thoroughly shows, embedded in nature study were the seeds of the first national movement to introduce science into the public elementary schools. *Teaching Children Science* presents an institutional account of the social context that "brought the idea of nature study into prominence, some of the key advocates who framed its fundamental principles, the complicated threads of preparation by teachers and supervisors who implemented it, and the multiple ways that the concept continued to resound long after the term had receded from school usage" (pp. 1–2). Additionally, it explores the ways that nature study introduced schoolchildren to civic science in the early twentieth century.

To date, historians have devoted relatively little attention to the nature study movement. Most studies of science education have tended to focus on the period following the Cold War, when the federal government supported efforts to reform precollege science education. Examples include John L. Rudolph's *Scientists in the Classroom: The Cold War Reconstruction of American Science Education* (Palgrave Macmillan, 2002) and J. Myron Atkin and Paul Black's *Inside Science Education Reform: A History of Curricular and Policy Change* (Teachers College Press, 2003). These and other authors have documented the close relationship between social developments and political agendas and representations of science in schools. Kohlstedt's meticulously crafted book demonstrates this relationship for a much earlier period. As the first book to integrate the different aspects of nature study in a comprehensive history of the earliest national movement to bring science into the nation's K–12 public schools, it fills a critical gap.

Kohlstedt argues that the combination of broad cultural enthusiasm for nature, changes in educational theory, and the involvement of scientists and educational leaders in the development of curriculum "catalyzed the surprisingly rapid introduction of nature study into the public schools in the 1890s" (p. 34). Nature study programs that sprang up around the country reflected the goals of natural scientists who wanted education to be based on scientific principles, psychologists who were interested in child development, and politicians and businessmen who wanted productive citizens.

One of the strengths of the book is its attention to local context and to the ways that particular communities shaped the development of nature study within their schools. Kohlstedt demonstrates that nature study was not implemented uniformly in schools across the country. For example, in cities like New York and St. Louis museums loaned boxes of zoological and botanical specimens and scientific instruments so that teachers could provide nature study lessons in their urban classrooms and school gardens. In rural areas, nature study often emphasized the application of scientific inquiry to problems in agriculture. Kohlstedt argues that attitudes about race and class status could also influence nature study programs. In the South, for instance, nature study programs in schools funded by northern philanthropists for African-American students maintained a distinctly vocational emphasis, with little time for scientific investigation.

Support for nature study declined after World War I, as scientists and educators sought to bring a more systematic form of elementary science education into the nation's public schools. As Kohlstedt points out, nature study had appealed to turn-of-the-century educators and a public who believed that science and cul-